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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/527,056	10/20/2005	Woo-Seok Cheong	123034-05029639	6957

22429 7590 08/31/2010
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EXAMINER	
FORD, NATHAN K	

ART UNIT	PAPER NUMBER
1712	

MAIL DATE	DELIVERY MODE
08/31/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/527,056	CHEONG ET AL.	
	Examiner	**Art Unit**	
	NATHAN K. FORD	1712	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 June 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-15* is/are pending in the application.

4a) Of the above claim(s) *1-5* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *6-15* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *09 March 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Applicant's Response

Acknowledged is the applicant's request for continued examination received June 1, 2010. Claims 6 and 9 are amended.

The applicant asserts that the cited prior art does not teach a second substrate holder and a sample holder which each comprise a ceramic heating element.

In response, the examiner concurs and has withdrawn the previous rejections. However, upon further search, a new rejection has been submitted which discloses these features.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 6-7 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine et al., US 6,488,778, in view of Shao et al., US 6,437,290, and in further view of Wu, US 2003/0235990, Bottomfield, US 6,506,312, Chen et al., 6,646,235, Honma, US 5,981,966, Holden et al., US 5,911,896, and Bagley et al., US 6,528,767.

Claim 6: Concerning the structural limitations recited by this claim, Ballantine teaches the following (Fig. 1):

- A first chamber (20) comprising:
  - A first substrate holder (24) positioned in a lower portion of the chamber;
  - A lamp provided in the upper portion of the chamber (4, 38-42);
  - A substrate door (4, 38-39);
- A second chamber, taken to include both units 40 (the lower portion) and 50 (the upper portion), comprising:
  - A second substrate holder (44) provided in the lower portion of the second chamber and capable of changing temperature when exposed to heat;
  - A middle film, taken to be the "selectively opened" demarcation between chambers 40 and 50, provided in the middle portion of the chamber (5, 1-6);
  - An elevating portion (46) attached to the second substrate holder;

  - o Wherein an LPCVD chamber must inherently comprise a metal depositing portion;
- A connecting portion (30) which connects the first and second chambers, wherein each chamber is selectively open to those chambers adjacent and maintains its own environment (4, 54-58).

Although Ballantine incorporates arrays of heating lamps, he does not specify whether these lamps are of the halogen type. Nevertheless, halogen lamps are well-known in the art. For example, Shao avails halogen lamps (51) to irradiate a sample, thereby demonstrating the suitability of using lamps of the halogen type for such purposes (10, 36-49). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate halogen lamps within the first chamber of Ballantine's apparatus to achieve the predictable result of irradiating a sample.

Concerning the process limitations recited by this claim, Ballantine teaches the following:

- Cleaning a substrate via rapid thermal processing using the first chamber (4, 30ff);
- Moving the substrate into the second chamber (40, 50);
- Depositing a metal film in the second chamber (claims 11, 19-21);
- Wherein each step is commenced and completed in the same processing location, i.e., batch processing, without exposure to ambient air (claim 11).

Ballantine deposits a metal film in chamber 50 by availing the technique of low-pressure chemical vapor deposition rather than sputtering. Nevertheless, concerning the deposition of a metal film, the interchangeability of these techniques is well-known in the art. Wu, for instance, asserts the equivalent efficacy of LPCVD and sputtering as applied to the fabrication of a MOSFET [0026]. Thus, given a disclosure demonstrating the art-recognized suitability of depositing a metal by either sputtering or LPCVD techniques, it would have been obvious to one of ordinary skill in the art to incorporate sputtering instruments within the Ballantine's processing chamber to achieve the predictable result of MOSFET fabrication via sputtering.

The references also omit the feature of a sputter shield. Bottomfield remedies the omission by disclosing a deposition chamber which executes sputtering techniques. Within the chamber a sputter shield (10) is disposed about a susceptor to protect the chamber walls from the excessive contamination which is inevitably produced during the sputtering process (5, 28-33). It would have been obvious to one of ordinary skill in the art to provide a shield to a processing chamber executing the technique of sputtering to protect the chamber walls from corrosive contamination.

Lastly, Ballantine does not specify the respective pressures of the upper and lower portions of the second chamber. However, the reference does state that the upper portion performs LPCVD processing (4, 67ff), whereas the

lower portion is merely a load chamber (5, 1-4). To supplement these omissions, Chen is cited to demonstrate the exemplary processing conditions of LPCVD, and Honma is cited to demonstrate the characteristic pressure settings of a load chamber.

Concerning the former, Chen asserts that typical vertical-furnace LPCVD processing occurs between 0.25-2.0 torr (1, 23-30). Thus, it would have been obvious to one of ordinary skill in the art to charge Ballantine's upper portion at 2.0 torr to facilitate the execution of LPCVD processing.

Regarding the latter, Honma describes a load chamber (17) operating at 1 torr disposed beneath a vertical furnace (13) (5, 41-49; Fig. 10). Likewise, it would have been obvious to one of ordinary skill to operate Ballantine's lower portion at 1torr to facilitate substrate loading.

Concerning the new material reciting heating elements formed in both the sample holder and the second substrate holder: In the second chamber (40) Ballantine disposes a frame (44) which encloses a plurality of substrates – the examiner is interpreting this frame as the "second substrate holder." Further, as the substrates are vertically stacked within the frame, there must exist a corresponding number of supports which respectively bear each substrate – the examiner is interpreting these supports as the "sample holders." Ballantine composes the frame of quartz, a ceramic (4, 61-62), and situates the frame within a temperature-controlled environment (6, 21-26), thus demonstrating the importance of temperature regulation in this context.

The reference does not disclose the method of adjusting heating elements respectively disposed within each of the substrate and sample holders. In supplementation, Holden describes a frame comprising a plurality of vertically aligned holders (24) to support substrates. In order to more effectively regulate the temperature of the substrates, Holden disposes ceramic heating elements (37, 38, 40) within the holders, which correspond to Ballantine's "sample holders" as defined above (3, 4-39). Further, the heating elements are especially configured to provide substantially uniform heating of the substrate (3, 40-43). Given that Ballantine independently teaches a need to maintain the substrates within a given temperature range, it would have been obvious to incorporate heating elements within Ballantine's sample holders to facilitate this objective of substrate heating and temperature control.

Bagley is cited to demonstrate that it is known in the art to dispose heating elements within a structure analogous to Ballantine's "second substrate holder" as defined above. With reference to Figure 1, Bagley delineates a substrate support frame (14) comprising vertically aligned sample holders (28). Within the support frame, heating coils (20) are embedded to promote temperature control of the substrates disposed on the sample holders (3, 13-30). It would have been obvious to the skilled artisan to incorporate heating coils within the frame of Ballantine's second substrate

holder in order to achieve the predictable result of substrate temperature control. Upon the integration of Bagley's coils, the ceramic walls of Ballantine's frame will themselves constitute heating elements.

Claim 7: The substrate is heated following the onset of deposition (6, 17-48).

Claim 15: Bottomfield does not address the means to control the wall temperature of the second chamber. In supplementation, Chen discloses the technique of circulating water through the walls of a processing chamber to control the temperature of the reaction space (6, 30-35). As previously stated, Ballantine intends to maintain the second processing chamber within a specified range; therefore, it would have been obvious to one of ordinary skill to incorporate cooling passages within the wall of the second chamber to facilitate the stated objective of temperature control.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine in view of Shao, Wu, Chen, Honma, Bottomfield, Holden, and Bagley as applied to claim 6 and in further view of Tsao, US 4,752,815.

Ballantine is silent regarding the growth of an oxide film. Tsao applies an oxide layer which is removed and then regrown to reduce the mechanical stress of the structure (3, 37-40). For this reason, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form an oxide layer in the second chamber of Ballantine prior to metal deposition, wherein the apparatus is capable of forming an oxide layer.

Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine in view of Shao, Wu, Chen, Honma, Bottomfield, Holden, and Bagley as applied to claim 6 and in further view of Tsao and Beinglass et al., US 5,940,733.

The rejection below is directed only to those limitations not addressed by the rejection of claim 6:

Claim 9: Tsao teaches the following:

- Positioning a substrate in a first chamber;
- The sequence of forming the following on said substrate (3, 20 – 4, 25):
  - A silicon layer (12);
  - A gate oxide layer (20);
  - A gate electrode (30);
  - A spacer (44, 46).

Tsao merely discloses the method of fabricating a schottky barrier MOSFET and is silent regarding the deposition structures which facilitate the fabrication process. Ballantine and Shao as applied to claim 1, however, disclose a deposition apparatus suitable for the fabrication of a schottky barrier MOSFET. As cited above, Ballantine teaches a method of cleaning a substrate using a first chamber prior to its transfer to a second chamber via a connecting portion to undergo deposition. A metal film is deposited by an LPCVD chamber, wherein the substrate is inserted vertically into the chamber. Thus, Ballantine and Shao provide the structural elements to facilitate the method disclosed by Tsao. It would have been obvious to one of ordinary skill in the art at the time the invention was made to perform the method of MOSFET fabrication disclosed by Tsao within the apparatus of Ballantine to achieve the predictable result of manufacturing a schottky barrier MOSFET.

Tsao does not address the further step of growing a silicide following the deposition of the metal film. Beinglass, disclosing a method of fabricating a polysilicon silicide composite, supplements this omission. Following the deposition of a metal layer, Beinglass transfers the substrate into another chamber for the express purpose of developing a silicide layer via heating at 500-600 degrees Celsius, as is well-known in the art (Abstract; 1, 17-39). Thus, considering Beinglass's general teaching of forming a silicide in a chamber distinct from that which the metal layer was deposited, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a silicide layer in a first chamber, as the metal deposition occurs in Ballantine's LPCVD chamber, that is, the second chamber. During the process of substrate transfer, the substrate is both "pulled up" and "pulled down."

Claim 10: Tsao applies an oxide layer which is removed and then regrown to reduce the mechanical stress of the structure (3, 37-40).

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine in view of Shao, Wu, Bottomfield, Chen, Honma, Holden, Bagley, Tsao, and Beinglass, and in further view of Brabant et al., US 2003/0036268 and Chang et al., 5,043,299.

Ballantine is silent regarding the condition of cleaning. Supplementing the omission is Chang, who discloses a method of selective tungsten deposition. Chang executes a hydrogen cleaning step (3, 20-25) wherein the pressure is maintained at 0.5 Torr (3, 41-43) and molecular hydrogen is flowed at 1 slm for 300 seconds (3, 34-35; 4, 26-30). The bake does not occur at a temperature between 700-900 degrees Celsius. Brabant, however, discloses a hydrogen bake process achieving the same end as Chang, that is, the removal of an oxide film [0102]. The reference states that a suitable temperature condition for the removal of an oxide would range from 750-900 degrees Celsius. Given this

disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to execute the hydrogen bake from within the range disclosed by Brabant to achieve the predictable result of removing a native oxide. It would be obvious to execute the hydrogen cleaning steps within the apparatus of Ballantine to achieve the predictable result of removing wafer contaminants prior to deposition.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tsao, Ballantine, Chen, Honma, Shao, Beinglass, Wu, Bottomfield, Holden, Bagley, and Chang in view of Adetutu, 5,958,508.

Ballantine is silent regarding the thickness of the deposited metal film. In supplementation, Chang deposits a one-micron tungsten film in the presence of argon (5, 14-17) and at a pressure of 200 milliTorr (5, 20-24). The prior art does not use a sputtering method to deposit the metal; nevertheless, such methods are well-known in the art. For instance, Adetutu, disclosing a method of semiconductor fabrication, states that it would suitable to deposit a tungsten layer by using either chemical vapor deposition (as does Chang and Ballantine) or sputtering (2, 40-42; 3, 18ff). Given Adetutu's affirmation of the art-recognized equivalence of CVD and sputtering for the purposes of delivering tungsten during semiconductor fabrication, it would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit a metal by using a sputtering method.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine and Shao in view of Tsao, Beinglass, Wu, Chen, Honma, Holden, Bagley, Bottomfield, and in further view of Aoki, US 5,242,666.

Although Beinglass performs the silicide formation at a pressure of only 500 millitorr (4, 40-45), it is well-known in the art that MOSFET formations can occur at the ultra-high vacuum conditions claimed by the applicant. For example, Aoki, disclosing a method of fabricating a MOSFET, maintains a pressure below 10^{-8} torr, thereby demonstrating the art-recognized suitability of such processing conditions (3, 40-50; 4, 26-29). It would have been obvious to one of ordinary skill in the art at the time the invention was made to employ these pressure to achieve the predictable result of MOSFET fabrication.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ballantine and Shao in view of Tsao, Bottomfield, Wu, Chen, Honma, Holden, Bagley, Beinglass, and Aoki and in further view of Yamoto et al., US 6,399,429.

Tsao does not address the conditions of formation of the sacrificial oxide film. Aoki, as described above, forms a MOSFET under operating conditions wherein the substrate temperature is maintained between 500-800 degrees

Celsius and the pressure is below 10^{-8} torr (3, 45-50). However, the gas type and potential flow rates are not addressed. Supplementing this deficiency is Yamoto, who teaches a method of MOSFET formation. During a step of oxide formation, SiH_4 is provided at a flow rate of 9 sccm for 166 seconds, thereby demonstrating the suitability of these conditions for MOSFET formation (7, 1ff). Further, both flow rate and deposition time are result effective variables; accordingly, it would have been obvious to one of ordinary skill to execute deposition under the claimed processing conditions since it has been held that discovering the optimum value of a result effective variable involves only routine skill in art (*In re Boesch*, 617 F.2d 272, 205 USPQ 215.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nathan K. Ford whose telephone number is 571-270-1880. The examiner can normally be reached on M-F, 8:30-5:00 EDT. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Cleveland, can be reached at 571-272-1418. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

/N. K. F./

Examiner, Art Unit 1712

/Michael Cleveland/

Supervisory Patent Examiner, Art Unit 1712